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The only remaining uncertainty in this result is the possible refraction effect, $\Delta\beta$, depending on the possible difference between the mean refrangibility of the light of *α Gruis* and that of the comparison stars.

As this effect, if at all sensible, must certainly depend on the difference between the types of the spectra of the principal star and the comparison star, it seems better to defer a discussion of the matter till the data referred to in a paper which I recently communicated to the Society (*Monthly Notices*, vol. lviii. p. 53) have been collected, and until I have access to the McClean telescope. The whole of this question, as it affects all these parallax researches, can then be dealt with on a broad and satisfactory basis. Meanwhile I venture to express the belief, founded on other considerations, that the value of $\Delta\beta$ will in this case not be found to amount to 0″·01.

It may interest the more casual reader to point out the great accuracy of the individual observations which the preceding results imply.

The probable error of the single observation of difference of two opposite distances is thus :—

For *Sirius* and comparison stars of 8¾ mag. ± 0″·070
,, *α Gruis* ,, ,, 8·0 mag. ± 0·042

This implies that, as the result of one complete set of observations lasting less than an hour, the position of the principal star may be projected on the great circle joining two comparison stars with a probable error of

± 0″·035 in the case of stars 8¾ mag.

or

± 0·021 in the case of stars 8·0 mag.

a precision which, so far as I am aware, has not been approached by any other method of observation, nor previously attained in astronomical researches of any kind. It becomes thus possible to detect any differential stellar parallax amounting to 0″·02 with perfect certainty by a comparatively small number of observations.

The Double Star ζ Boötis. Σ 1865. By S. W. Burnham.

This double star was discovered by Herschel a little more than one hundred years ago (=H. N. 114). In his first observation, 1796 April 5, it is described as "very nearly in contact; I can, however, see a small division." On the following evening he measured the position-angle, which is given as 41′ 59″ *n.p.*

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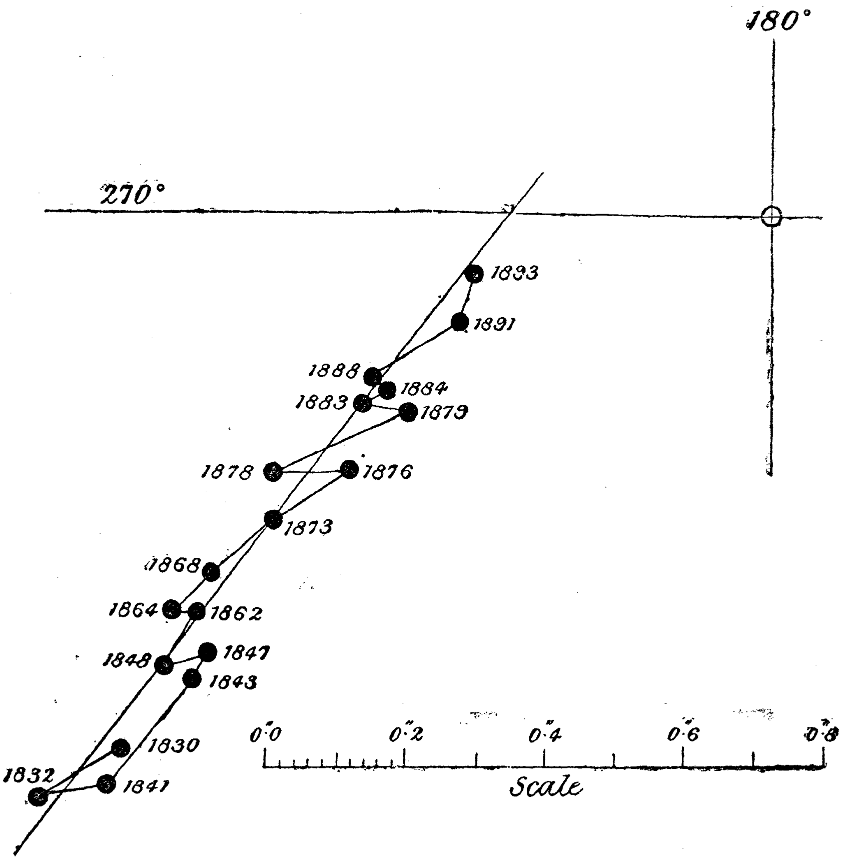
(*Mem. R.A.S.* vol. i.); but this appears from his diagram to be a misprint for 41° 59′, giving 312° for the position-angle as now reckoned. This is the value given by Herschel II. in the Synopsis of his father's double-star observations. On the last-mentioned date Herschel says, "With 460 a division is but barely visible $\frac{1}{4}$ of S" (referring to the diameter of the smaller star). His last observation was 1807 July 12, when he noted, "The interval between their apparent disks with 460 is $\frac{1}{3}$ of the diameter of either." The next observation appears to be by Amici in 1815 (*Zach. Corr. Astron.* vol. viii.), who measured the distance as 1″, but did not measure the angle. In 1823 South on one night measured both angle and distance, and made the latter 1″·68. He refers to Amici's distance as being "probably too small." The observations of Struve commence in 1827, and since that time this pair has been measured by most of the prominent double-star observers.



ζ Boötis. Σ 1865.

The earlier measures appeared to show little or no change, and Dawes, referring to the observations down to 1853, says: "Notwithstanding considerable discrepancies in the results, no

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sufficient ground appears for suspecting relative motion. The oblique position of the components may in great measure account for the errors of observation, where no suitable precautions have been taken to avoid its effects." Since that time, however, the distance has steadily decreased, and it is now certain that the most reliable measures show a regular diminution in the distance during the entire interval. In later times it has generally been regarded as a binary of long period.

In an investigation of the character of the relative motion of these stars, it is certainly better to rely as far as possible upon the micrometrical results obtained by the most experienced observers in this field, and accordingly I have given on the diagram accompanying this paper a selection of the best measures, commencing with Struve. It will be seen from these positions that the apparent movement of the smaller component has no sensible variation from rectilinear motion. It is obvious that when this movement is not in the line of the principal star it must follow a curved path of some kind if the stars form a binary system, but the orbit might be such that the variation of the described arc from a right line could not be eliminated from the ordinary errors of observation in a pair of this class where the distance for the greater part of the time has been less than 1″.

Whether the change is due to the slow revolution of one star about the other, or to the proper motion of one or both components, the theory of rectilinear motion, at least down to the present time, will satisfy the observations with all desirable accuracy. An examination of the positions given shows that the companion star has moved 0″·89 in the direction of 142°·5 since 1831, or about 0″·0143 annually. It will be seen that these positions depend largely upon the distances alone. The change in the angle has been slow during nearly the whole interval, and the error in the measures upon any theory is therefore principally in the distances. The corrections to be applied to the observed distances in the measures shown on the diagram are as follows :—

	″		
1830·47	+0·21	11*n*	Σ
1832·47	−0·05	3*n*	Da
1841·16	−0·10	6*n*	OΣ
1843·40	+0·07	7*n*	Ma
1847·72	+0·08	8*n*	OΣ
1848·11	−0·03	6*n*	Da
1862·95	−0·13	11*n*	OΣ
1864·78	−0·17	8*n*	Δ
1868·59	−0·16	8*n*	OΣ, Δ
1873·01	−0·12	4*n*	OΣ
1876·47	−0·03	8*n*	OΣ, Hl

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	″		
1878·48	−0·14	2*n*	Δ
1879·04	+0·04	5*n*	Hl
1883·17	−0·06	3*n*	OΣ
1884·43	−0·03	3*n*	Hl
1888·54	−0·09	2*n*	OΣ
1891·31	+0·01	3*n*	β
1893·51	+0·03	5*n*	Lewis, Lv

For the most part, these corrections are as small as would be found generally in measures of a star of this class, and they cannot be materially lessened upon any other theory of motion. If the companion continues to move uniformly in the direction indicated, the minimum distance of 0″·29 will be reached about 1917.

The meridian observations of ζ *Boötis* show a small proper motion. Porter gives the annual movement as 0″·030 in the direction of 109°·6. As this star would be apparently single in all meridian instruments, this value would probably represent the mean of the two components. Taking it as the motion of the principal star, we have the following relation between the two:—

Proper motion of A	0″·030 in 109°·6
Proper motion of B	0″·043 in 119°·9

With uniform rectilinear motion, the distance between the two stars at the time of Herschel's observations in 1796 would be 1″·74, and this agrees well with his position-angle at that time. It would seem at first that his descriptions of this pair, as already mentioned, would call for a smaller distance than that given above; but when we examine similar descriptions by Herschel of various stars of his Class I., where he has compared the distance between the components to the apparent diameter of one or the other of the stars, we find several instances where the distances at that time, as determined from the later history of the motion, could not have been less than 1″·7, so there is nothing in these early observations inconsistent with the theory of uniform motion. It will probably be a long time before the true relation of these stars is known with absolute certainty. At present it seems to belong to the 61 *Cygni* type of double stars, where the components are moving together in space, but with slightly different velocities and directions. We have now some forty or fifty of these pairs, and in most of them there is now little doubt of the relative change being entirely due to the difference of proper motion.

Yerkes Observatory:
December 13.

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The Orbit of OΣ 400. By S. W. Burnham.

This close pair of the Pulkowa Catalogue, discovered by Otto Struve something more than half a century ago, was first measured by Mädler in 1843. The measures of OΣ commence in 1844, and continue at intervals down to 1861. It received special attention from Dembowski, who examined it on eleven nights 1865–77, and measured the angle whenever he could do so, but the distance was too small to be measured with his aperture. Since that time very few measures have been made. A large instrument has been necessary in recent years to show any measurable elongation.

One orbit has been computed of this pair. Gore (*Monthly Notices*, xlvii. 346) from the positions to 1885 found a period of 170·37 years.

The following are all the observations of this pair :—

1843·39	326°·7	0″·5 ±	2*n*	Mädler
*1845·73	334·9	0·64	3*n*	O. Struve
*1853·25	324·6	0·59	2*n*	O. Struve
1853·89	320·5	0·65 ±	1*n*	Dawes
*1860·10	319·3	0·62	2*n*	O. Struve
*1865·72	310·7	...	2*n*	Dembowski
1868·55	301·6	obl.	1*n*	Dembowski
1871·04	301·2	oval	2*n*	Dembowski
1872·62	314·9	obl ?	1*n*	Dembowski
1873·88	94·0 ?	obl ?	2*n*	Dembowski
1874·50	107·8	obl ?	1*n*	Dembowski
*1875·67	267·9	0·3 ±	3*n*	Schiaparelli
1877·59		Single	1*n*	Dembowski
1878·65		Single	1*n*	Burnham
1879·82	150·2	> 0·5 ±	2*n*	Seabroke
1880·68		Single ?	1*n*	Schiaparelli
1881·70		Single	1*n*	Bigourdan
1883·62		"not divided"	1*n*	Seabroke
*1883·63	185·3	0·35 ±	1*n*	Schiaparelli
1885·72	144·5	0·3 ±	2*n*	Young
1886·77	122·7	0·3 ±	1*n*	Hough
*1887·91	140·1	0·25 ±	1*n*	Schiaparelli
1892·79	300 ±	0·2 ±	1*n*	Comstock
1895·73	346·8	0·2 ±	2*n*	See
1895·76		Single	1*n*	Comstock